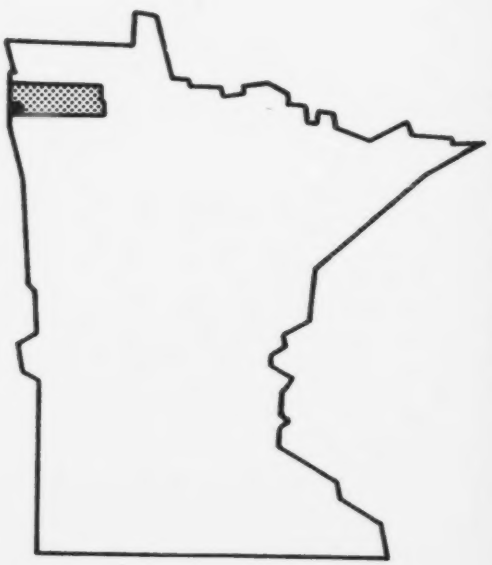
JUN 1 1 1982

594-C-26 FEM 1.209:270272

COMPLETED
24
ORIGINAL

FLOOD INSURANCE STUDY



CITY OF OSLO, MINNESOTA
MARSHALL COUNTY

MARCH 16, 1982

Federal Emergency Management Agency

COMMUNITY NUMBER - 270272

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
	1.1 Purpose of Study	1
	1.2 Authority and Acknowledgements	1
	1.3 Coordination	1
2.0	AREA STUDIED	2
	2.1 Scope of Study	2
	2.2 Community Description	2
	2.3 Principal Flood Problems	4
	2.4 Flood Protection Measures	4
3.0	ENGINEERING METHODS	6
	3.1 Hydrologic Analyses	6
	3.2 Hydraulic Analyses	7
4.0	FLOOD PLAIN MANAGEMENT APPLICATIONS	7
	4.1 Flood Boundaries	8
	4.2 Floodways	8
5.0	INSURANCE APPLICATION	9
	5.1 Reach Determinations	9
	5.2 Flood Hazard Factors	11
	5.3 Flood Insurance Zones	11
	5.4 Flood Insurance Rate Map Description	13
6.0	OTHER STUDIES	13
7.0	LOCATION OF DATA	14
8.0	REFERENCES AND BIBLIOGRAPHY	15

BEST DOCUMENT AVAILABLE

TABLE OF CONTENTS (Continued

	Page
FIGURES	
Figure 1 - Vicinity Map	3
Figure 2 - City of Oslo, 1979 Flood	5
Figure 3 - City of Oslo, 1978 Flood	5
Figure 4 - Floodway Schematic	9
TABLES	
Table 1 - Summary of Discharges	6
Table 2 - Floodway Data	10
Table 3 - Flood Insurance Zone Data	12
EXHIBITS	
Flood Profiles: Red River of the North	Panel 01P
Flood Boundary and Floodway Map	

PUBLISHED SEPARATELY: Flood Insurance Rate Map

BEST DOCUMENT AVAILABLE

FLOOD INSURANCE STUDY

CITY OF OSLO

MARSHALL COUNTY, MINNESOTA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Oslo, Marshall County, Minnesota, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert the City of Oslo to the regular program of flood insurance by the Federal Emergency Management Agency (FEMA). Local and regional planners will also use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these Federally-supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.1(d). In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by Edwards and Kelcey, Inc. for the Federal Emergency Management Agency, under Contract No. EMW-C-0322. This study was completed in March 1981.

1.3 Coordination

The flood problems of the City of Oslo were identified at a meeting in June 1979 attended by the Federal Emergency Management agency (FEMA), the Minnesota Department of Natural Resources (Mn/DNR), the Study Contractor, and the community representatives.

The peak discharges for the Red River of the North at Oslo were coordinated with the Mn/DNR, the U.S. Army Corps of Engineers (COE), the U.S. Geological Survey (USGS), the Soil Conservation Service

BEST DOCUMENT AVAILABLE

(SCS), and the Minnesota Department of Transportation (Mn/DOT). Interagency approval was received December 15, 1980.

On October 6, 1981, the results of the work by the Study Contractor were reviewed and accepted at a final coordination meeting attended by representatives of the Study Contractor, FEMA, and the community.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Oslo, Marshall County, Minnesota. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas, and areas of projected development or proposed construction for the next five years, through March 1986. The Red River of the North within the corporate limits of Oslo, was studied by detailed methods.

2.2 Community Description

The City of Oslo is located in northwestern Minnesota, in extreme southwestern Marshall County. The city is approximately 20 miles north of East Grand Forks, Minnesota and 18 miles west of Warren, Minnesota. Oslo is bordered by the Red River of the North and unincorporated areas of Walsh County, and Grand Forks County, North Dakota to the west and unincorporated areas of Marshall County, Minnesota to the north, east and south. The total land area within the corporate limits is about 0.5 square miles. The population was 417 in 1970 (Reference 1).

Oslo is the geographic region of Minnesota known as the Red River Valley. This flat expanse of land was not technically formed by the Red River of the North but by the action of glacial Lake Agassiz. The flat lake bed which covers a large portion of northwestern Minnesota was formed by sediments hundreds of feet thick. The topography of Oslo is flat with elevations ranging from 785 to 805 feet (Reference 2). Development in Oslo is primarily residential/ commercial; the regional land use is chiefly agricultural.

The lake plain surrounding Oslo is an area of fine textured prairie soil that is intensively farmed. The principal crops are small grains and sugar beets. Prior to settlement in the area, the lake plain was covered primarily by prairie grasses and plants with trees along the major streams and rivers.

The Red River of the North begins at the confluence of the Bois de Sioux and Otter Tail Rivers at Breckenridge, Minnesota and flows 600 river miles north through the center of the Old Lake Agassiz bed to its mouth in Lake Winnipeg (Reference 4).

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

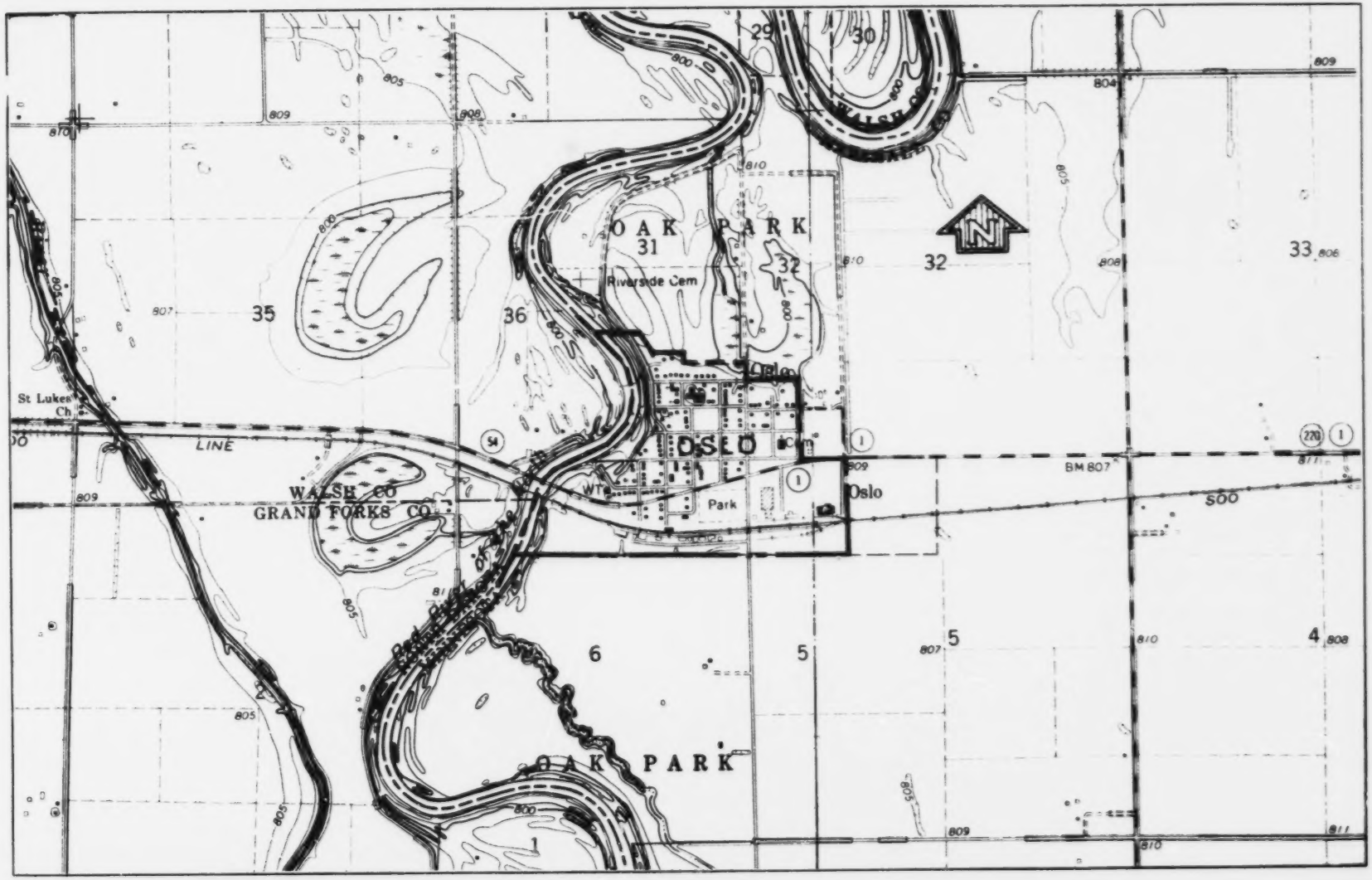


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF OSLO, MN
(MARSHALL CO.)

APPROXIMATE SCALE

2000 0 2000 4000 6000 FEET

VICINITY MAP

The flood plain of the Red River of the North is not very well defined, as it was not formed by the River's action but rather by the lake sediments. The City of Oslo is directly adjacent to the Red River of the North and is subject to any out-of-bank flooding.

The climate of the area is continental, characterized by wide variations in temperatures, scant winter precipitation, and a general tendency toward extremes. In July, the average high is 79 degrees Fahrenheit (F), and the average low is 54 degrees F. In winter, the average high is 16 degrees F and the average low is -16 degrees F. The average annual precipitation at Oslo is 19 inches, with about 75 percent falling between April and October. Snowfall averages 30 inches per year and represents 16 percent of the average annual precipitation (Reference 3).

2.3 Principal Flood Problems

The Red River of the North has historically flooded in the spring due to rapid snowmelt generally accompanied by spring rains. The Red River of the North flows north, which compounds the flooding problem; the downstream reaches of the river are still frozen when the upstream reaches are beginning to flow from spring snowmelt. Runoff from tributary streams is generally synchronized with main-stem flows, increasing the resultant flood peak.

Major flooding on the Red River of the North has occurred 17 times since 1882. The flood of record occurred in April 1979; this event had a recurrence interval of approximately 100 years in the reach from Grand Forks to Oslo. Other past floods in Oslo include events in 1950, 1966, 1969 and 1978 (References 5 and 6).

Views of the 1979 and 1978 flood events are shown in Figures 2 and 3.

Flood Date	Elevation (Feet)	Discharge (cfs)	Estimated Frequency (Years)
April 1979	811.25	91,000	100
May 1950	809.48	63,000	29
April 1966	809.73	59,000	25
April 1969	809.57	56,500	22
April 1978	810.56	56,200	20

2.4 Flood Protection Measures

In 1975, the U.S. Army Corps of Engineers (COE) constructed a ring levee surrounding the developed portion of Oslo, Minnesota. This levee was designed to provide protection during the 100-year flood event with a three foot freeboard. The Corps considers this levee to provide permanent protection from the 100-year event under COE

BEST DOCUMENT AVAILABLE

FIGURE 2 - CITY OF OSLO, 1979 FLOOD

FIGURE 3 - CITY OF OSLO, 1978 FLOOD

BEST DOCUMENT AVAILABLE

criteria. FEMA also considers the Oslo levee to meet their levee policy criteria; effects of the levee have been incorporated into this report.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence intervals), have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10, 50, 100 and 500-year floods, have a 10, 2, 1 and 0.2 percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one percent chance of annual occurrence) in any 50-year period is about 40 percent (four in ten), and for any 90-year period, the risk increases to about 60 percent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied by detail methods affecting the community.

The Army Corps of Engineers (COE) used gaging stations records for the Red River of the North at Oslo, Minnesota in their flood frequency analysis at Oslo. This analysis was performed for the report Red River of the North Main Stem Hydrologic Data prepared by the COE in October 1977 (Reference 7). The peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGE (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
THE RED RIVER OF THE NORTH AT OSLO	31,200	43,000	75,500	91,000	132,000

BEST DOCUMENT AVAILABLE

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the flooding sources studied in detail in Oslo were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along the flooding source studied in detail.

Locations of selected cross sections used in the hydraulic analyses are shown on the flood profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map.

Channel cross sections, including the landward side of the levee, were obtained by the COE using field surveys. Overbank areas for each cross section were interpolated from USGS quadrangle sheets with a scale of 1:24000, which have a 5-foot contour interval (Reference 2). Cross sections for the backwater analysis were located at close intervals above and below bridges in order to compute significant backwater effects.

Water-surface profiles for the various frequency floods on the Red River of the North were computed by the COE for their ongoing hydraulic analysis of the Red River of the North. The computational model used was the COE HEC-2 step-backwater computer program (Reference 8). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Effective flow areas of the flood plain cross sections and channel and overbank roughness coefficients (Manning's "n") were selected by the COE for each cross section using field inspection data and engineering judgment. Roughness values vary from 0.036 to 0.046 for the main channel and from 0.01 to 0.125 for the overbanks of the Red River of the North.

The flood profiles were computed on the basis of full hydraulic efficiency of the stream channels and structures, without consideration of the effects of obstruction. While such obstructions can be the cause of flooding in localized areas, the frequency of occurrence and severity of such obstructions is unpredictable. Flow in overbank areas was subject to an effective flow analysis; areas outside the effective flow limits and below the flooding elevations were considered to be in storage. The flood elevations shown on the water-surface profiles are considered valid only if the hydraulic structures remain unobstructed, and if channel and overbank conditions remain essentially the same as ascertained during the study.

All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments

BEST DOCUMENT AVAILABLE

to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Emergency Management Agency as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100- and 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using USGS quadrangle mapping photo-enlarged to a scale of 1:6000 with a contour interval of 5 feet (Reference 2).

The boundaries of the 100-year and 500-year floods are shown on the Flood Boundary and Floodway Map. Small areas within the flood boundaries may lie above the flood elevations, and therefore would not be subject to flooding; owing to lack of detailed topographic information or to limitations of the map scale; such areas are not shown. In cases where the 100-year and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum standards of the Federal Emergency Management Agency limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. In Minnesota, however, flood plain encroachment is limited by Minnesota Regulations to that which would cause a 0.5-foot increase in flood heights above pre-floodway conditions at any point (Reference 9). Floodways having no more than a 0.5-foot surcharge were delineated for this study.

The floodway presented in this study has been computed with regard to existing and proposed development and has been coordinated with the City of Oslo and the Minnesota Department of Natural Resources. The floodway chosen corresponds to the inside toe-of-slope of the permanent ring levee. This community designated floodway was analyzed utilizing the HEC-2 Computer Program (Reference 8). The

BEST DOCUMENT AVAILABLE

results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 2). Portions of the floodway for the Red River of the North lies outside the corporate limits.

As shown on the Flood Boundary and Floodway Map, the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 0.5 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 4.

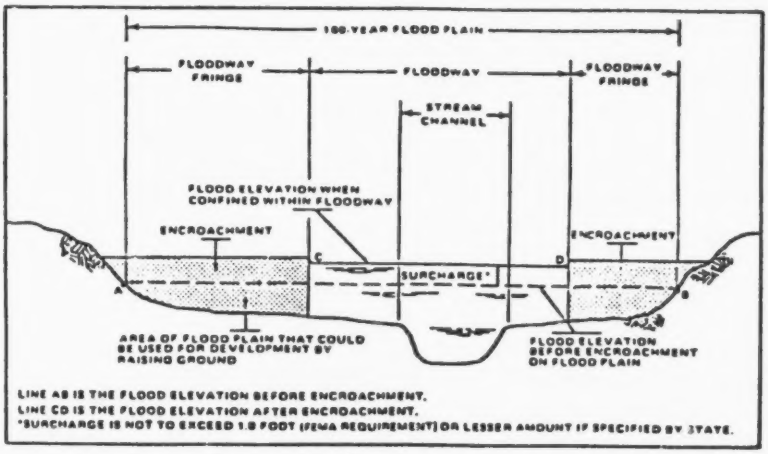

100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FIGURE 4 - FLOODWAY SCHEMATIC

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the Federal Emergency Management Agency has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factor (FHF) and flood insurance zone designations for each flooding source studied in detail affecting the City of Oslo.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water

BEST DOCUMENT AVAILABLE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY	INCREASE (FEET)
RED RIVER OF THE NORTH								
A	320	30936/400	133232	0.7	810.4	810.4	810.4	0.0
B	2627	31389/580	124635	0.7	810.5	810.5	810.5	0.0
C	3163	22200/2550	96073	0.9	811.2	811.2	811.2	0.0

[1] FEET ABOVE CORPORATE LIMITS

[2] TOTAL WIDTH/WIDTH WITHIN CORPORATE LIMITS

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF OSLO, MN.
(MARSHALL COUNTY)

FLOODWAY DATA

RED RIVER OF THE NORTH

BEST DOCUMENT AVAILABLE

surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-Year Floods	Variation Permitted
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The location of the reaches determined for the City of Oslo, Minnesota, are shown on the Flood Profiles and are summarized in the Flood Insurance Zone Data Table (Table 3).

5.2 Flood Hazard Factors (FHF)

The Flood Hazard Factor is used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their assigned FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest one-half foot and shown as a three-digit code. For example, if the difference between the water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, the accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire City of Oslo was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A4: Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones assigned according to FHFs.

Zone B: Areas between the Special Flood Hazard areas and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; or areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

BEST DOCUMENT AVAILABLE

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION (FEET NGVD)[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
RED RIVER OF THE NORTH							
Reach 1	0001	-2.0	-0.3	0.9	020	A4	Varies - See Map

[1]FLOOD INSURANCE RATE MAP PANEL [2]WEIGHTED AVERAGE [3]ROUNDED TO NEAREST FOOT

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF OSLO, MN.
(MARSHALL COUNTY)

FLOOD INSURANCE ZONE DATA

RED RIVER OF THE NORTH

BEST DOCUMENT AVAILABLE

Zone C: Areas of minimal flooding.

Table 3, "Flood Insurance Zone Data", summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map (FIRM) for the City of Oslo is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the Federal Emergency Management Agency.

6.0 OTHER STUDIES

The Red river of the North Regional Flood Analysis, prepared by the North Dakota State Water Commission and the Minnesota Department of Natural Resources (Reference 10), includes an approximate 100-year flood profile which was extrapolated from existing rating curves and the 1950 historic flood profile. In this Flood Insurance Study, the 1969 historic flood profile was used to calibrate the Red River of the North HEC-2 computer model. Compared with the 1950 flood, the 1969 flood more accurately reflects existing conditions and more highwater marks were available in the detailed study reaches. Differences between the profiles in the two studies result from the emphasis on different historic flood profiles to develop the 100-year profile.

Other reports include the Red River of the North and Souris River, Post Flood Report - 1979 and Red River of the North Post Flood Report - 1978 prepared by the U.S. Army Corps of Engineers, St. Paul District (References 5 and 6) which give an in-depth analysis and comparison of the 1978 and 1979 post flood events of the Red River of the North. No direct comparison was made between above reports and this Flood Insurance Study.

The Red River of the North Main Stem, Hydrologic Data, prepared by the Corps of Engineers provided the hydrologic analysis and flood profiles for the Red River of the North (Reference 7). The above study and this Flood Insurance Study are in agreement.

A Flood Hazard Boundary Map (FHBM) for Oslo has been published by the Federal Insurance Administration (Reference 11). The differences between the Flood Hazard Boundary Map and this study are justified due to the more detailed nature of this Flood Insurance Study.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

BEST DOCUMENT AVAILABLE

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic and other pertinent data used in this study can be obtained by contacting the Insurance and Mitigation Division, Federal Emergency Management Agency, 300 South Wacker Drive, (24th Floor), Chicago, Illinois 60606.

BEST DOCUMENT AVAILABLE

8.0 REFERENCES AND BIBLIOGRAPHY

1. Office of the State Demographer, State Planning Agency, Division of Development Planning, Minnesota Population Projections, 1970-2000, St. Paul, Minnesota, November 1975.

2. U.S. Geological Survey, 7.5 Minute Series Topographic Maps for Minnesota, Scale 1:24000, Contour Interval Five Feet, Oslo.

3. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Services, Climatological Data for Minnesota, Asheville, North Carolina, January 1975.

4. Thomas F. Waters, Streams and Waters of Minnesota, University of Minnesota Press, Minneapolis, Minnesota 1977.

5. U.S. Army Corps of Engineers, St. Paul District, Red River of the North and Souris River Post Flood Report, St. Paul, Minnesota 1979.

6. U.S. Army Corps of Engineers, St. Paul District, Red River of the North Post Flood Report, St. Paul, Minnesota 1978.

7. U.S. Army Corps of Engineers, St. Paul District, Red River of the North Main Stem - Hydrologic Data, October 1977.

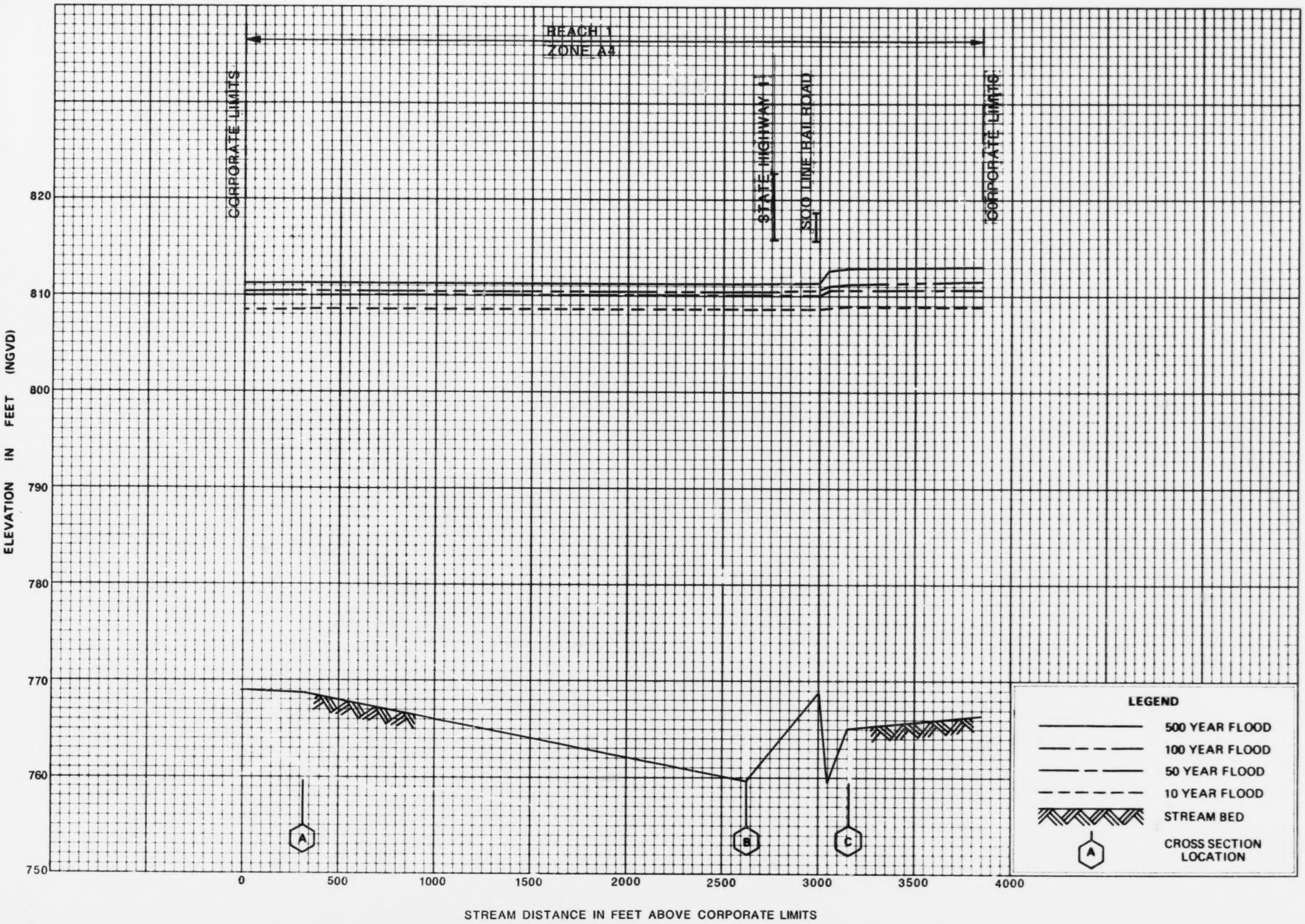
8. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water-Surface Profiles, Computer Program 723-X6-L202A, Davis, California, November 1976.

9. Minnesota Department of Natural Resources, Division of Water, Technical Report No. 6, The Regulatory Floodway in Floodplain Management, September 1977.

10. North Dakota State Water Commission, State Office Building, Bismarck, North Dakota; and Minnesota Department of Natural Resources, Soils and Minerals, Centennial Office Building, St. Paul, Minnesota, Red River of the North Regional Flood Analysis, August 1971.

11. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Oslo, Minnesota, December 20, 1974.

BEST DOCUMENT AVAILABLE



FLOOD PROFILES

RED RIVER OF THE NORTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF OSLO, MINNESOTA
(MARSHALL COUNTY)

01P

BEST DOCUMENT AVAILABLE